HDP/SB/21 based on PTO/SB/21 (08-00)

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TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	**09/850,124**
Filing Date	May 7, 2001
Inventor(s)	Krishna BALACHANDRAN et al.
Group Art Unit	2634
Examiner Name	Eva Y. Zheng
Attorney Docket Number	29250-000873/US

ENCLOSURES *(check all that apply)*

☒ Fee Transmittal Form

    ☒ Fee Attached

☐ Amendment

    ☐ After Final

    ☐ Affidavits/declaration(s)

☐ Extension of Time Request

☐ Express Abandonment Request

☐ Information Disclosure Statement

☐ Certified Copy of Priority Document(s)

☐ Response to Missing Parts/ Incomplete Application

☐ Response to Missing Parts under 37 CFR 1.52 or 1.53

☐ Assignment Papers *(for an Application)*

☐ Letter to the Official Draftsperson and _____ Sheets of Formal Drawing(s)

☐ Licensing-related Papers

☐ Petition

☐ Petition to Convert to a Provisional Application

☐ Power of Attorney, Revocation Change of Correspondence Address

☐ Terminal Disclaimer

☐ Request for Refund

☐ CD, Number of CD(s) _____

☐ After Allowance Communication to Group

☐ LETTER SUBMITTING APPEAL BRIEF AND APPEAL BRIEF (w/clean version of pending claims)

☒ Appeal Communication to Group *(Notice of Appeal, **Brief**, Reply Brief)*

☐ Proprietary Information

☐ Status Letter

☐ Other Enclosure(s) *(please identify below)*:

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm or Individual name	Harness, Dickey & Pierce, P.L.C.	Attorney Name John E. Curtin	Reg. No. 37,602
Signature			
Date	April 29, 2005		

FEE TRANSMITTAL
for FY 2005

Effective 10/01/2004. Patent fees are subject to annual revision.

☒ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT | ($) 500

Complete if Known	
Application Number	09/850,124
Filing Date	May 7, 2001
First Named Inventor	Krishna BALACHANDRAN
Examiner Name	Eva Y. Zheng
Art Unit	2634
Attorney Docket No.	29250-000873/US

(stamp: OIPE, APR 29 2005, PATENT & TRADEMARK)

METHOD OF PAYMENT *(check all that apply)*

☒ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None

☒ Deposit Account:

Deposit Account Number	08-0750
Deposit Account Name	Harness, Dickey & Pierce, PLC

The Director is authorized to: *(check all that apply)*
☐ Charge fee(s) indicated below ☐ Credit any overpayments
☐ Charge any additional fee(s) during the pendency of this application
☐ Charge fee(s) indicated below, **except for the filing fee** to the above-identified deposit account.

FEE CALCULATION

1. BASIC FILING FEE

Large Entity		Small Entity			
Fee Code	Fee ($)	Fee Code	Fee ($)	Fee Description	Fee Paid
1011	300	2011	150	Utility filing fee	
1012	200	2012	100	Design filing fee	
1013	200	2013	100	Plant filing fee	
1014	300	2014	150	Reissue filing fee	
1005	200	2005	100	Provisional filling fee	

SUBTOTAL (1) | ($) 0

2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

		Extra Claims	Fee from below	Fee Paid
Total Claims	-20 ** =	0	X	= 0
Independent Claims	-3 ** =	0	X	= 0
Multiple Dependent				= 0

Large Entity		Small Entity			
Fee Code	Fee ($)	Fee Code	Fee ($)	Fee Description	
1202	50	2202	25	Claims in excess of 20	
1201	200	2201	100	Independent claims in excess of 3	
1203	360	2203	180	Multiple dependent claim, if not paid	
1204	200	2204	100	** Reissue independent claims over original patent	
1205	50	2205	25	** Reissue claims in excess of 20 and over original patent	

SUBTOTAL (2) | ($) 0

**or number previously paid, if greater; For Reissues, see above

FEE CALCULATION (continued)

3. ADDITIONAL FEES

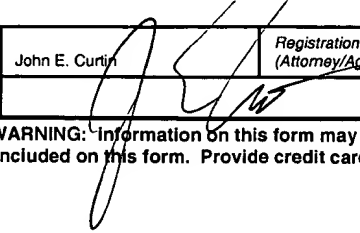| Large Entity		Small Entity			
Fee Code	Fee ($)	Fee Code	Fee ($)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet.	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	120	2251	60	Extension for reply within first month	
1252	450	2252	225	Extension for reply within second month	
1253	1020	2253	510	Extension for reply within third month	
1254	1,590	2254	795	Extension for reply within fourth month	
1255	2,160	2255	1080	Extension for reply within fifth month	
1401	500	2401	250	Notice of Appeal	
1402	500	2402	250	Filing a brief in support of an appeal	500
1403	1000	2403	500	Request for oral hearing	
1452	500	2452	250	Petition to revive – unavoidable	
1453	1500	2453	750	Petition to revive – unintentional	
1501	1400	2501	700	Utility issue fee (or reissue)	
1502	800	2502	400	Design issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17 (q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	790	2809	395	Filing a submission after final rejection (37 CFR § 1.129(a))	
1810	790	2810	395	For each additional invention to be examined (37 CFR § 1.129(b))	
1801	790	2801	395	Request for Continued Examination (RCE)	

Other fee (specify) _____

*Reduced by Basic Filing Fee Paid   **SUBTOTAL (3)** | ($)500

4. SEARCH/EXAMINATION FEES

1111	500	2111	250	Utility Search Fee	
1112	100	2112	50	Design Search Fee	
1113	300	2113	150	Plant Search Fee	
1114	500	2114	250	Reissue Search Fee	
1311	200	2311	100	Utility Examination Fee	
1312	130	2312	65	Design Examination Fee	
1313	160	2313	80	Plant Examination Fee	
1314	600	2314	300	Reissue Examination Fee	

SUBTOTAL (4) | ($)0

SUBMITTED BY				Complete *(if applicable)*	
Name (Print/Type)	John E. Curtin	Registration No. (Attorney/Agent)	37,602	Telephone	(703) 668-8000
Signature				Date	April 29, 2005

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Appeal No. _____

Appellants:	Krishna BALACHANDRAN et al.
Application No.:	09/850,124
Group No.:	2634
Filed:	May 7, 2001
Examiner:	Eva Y. Zheng
For:	ENHANCED FREQUENCY HOPPING IN A WIRELESS SYSTEM
Attorney Docket No.:	29250-000873/US

BRIEF ON APPEAL ON BEHALF OF APPELLANT

Customer Service Window
Randolph Building
401 Dulany Street
Alexandria, VA 22314
Mail Stop Appeal Brief - Patents

April 29, 2005

TABLE OF CONTENTS

BRIEF ON BEHALF OF APPELLANT

In support of the Notice of Appeal filed April 5, 2005, appealing the Examiner's Final Office Action mailed January 7, 2005 rejecting each of pending claims 1, 3, 5, 6, 15-17, 19, 21 and 22 of the present application which appear in the attached Appendix A, Appellant hereby provides the following remarks.

I.   REAL PARTY IN INTEREST

The present application is assigned to Lucent Technologies Inc., by an Assignment recorded on August 24, 2001, Reel 012109, Frame 0573.

II.   RELATED APPEALS AND INTERFERENCES

The Appellant does not know of any appeals or interferences which would directly affect or which would be directly affected by, or have a bearing on, the Board's decision in this Appeal.

III.   STATUS OF THE CLAIMS

The claims reproduced in the attached Appendix A are the claims on appeal. Each of these claims is currently pending in the application.

In addition, Appellants note that the Examiner has admitted that claims 8-10, 12-14 and 24-26 (also included in Appendix A) contain allowable subject matter and would be allowable if rewritten in independent form. Accordingly, irrespective of the outcome of this Appeal, Appellants reserve the right to re-write any and all of these objectionable claims into independent form to place them in condition for allowance.

IV. STATUS OF ANY AMENDMENTS FILED SUBSEQUENT TO THE FINAL REJECTION

A Request for Reconsideration ("Request") dated April 5, 2005 was filed with the U.S. Patent and Trademark Office in response to the Final Office Action. In an April 20, 2005 Advisory Action, this Request was considered but not entered by the Examiner.

V. SUMMARY OF THE CLAIMED SUBJECT MATTER

Advances in wireless technologies have propelled a migration in features and services provided to the end user. Network operators may, however, need to support multiple and perhaps migratory technologies with limited spectrum. Therefore, radio resource management techniques that improve spectral efficiency and/or system capacity are always of interest to network operators.

Higher spectral efficiency and/or voice capacity can be achieved in the Global System for Mobile Communication (GSM) Enhanced Data rates for Global Evolution (EDGE) Radio Access Network (GERAN) through tight frequency reuse (e.g., 1/3 or 1/1 reuse). Current GSM deployments employ techniques such as frequency hopping in order to combat the effects of fading and interference. The performance improvement achieved through frequency hopping for voice users at the link and system level directly translates into higher capacity.

On a GSM full rate traffic channel, 20 ms (milli-second) speech frames are convolutionally encoded and diagonally interleaved over a sequence of 8 bursts in a time slot. In the case of a half rate channel, speech is coded and diagonally interleaved over a sequence of 4 alternate bursts in a time slot. Frequency hopping is carried out burst by burst in order to mitigate the effects of slow fading and interference. It provides the following benefits: fading diversity, interferer diversity, and interference averaging (excerpts from specification, p. 1).

In practical systems, frequency hopping is typically non-ideal and the benefits of fading and interferer diversity are not fully realized. With respect to frequency hopping techniques, GSM specifies cyclic frequency hopping and pseudo-random frequency hopping (e.g., see 3GPP TS 45.002, "3rd Generation Partnership Project; Technical Specification Group GERAN; Digital Cellular telecommunications System (Phase 2+); Multiplexing and Multiple Access on the Radio Path (Release 4)"). If the number of frequencies is sufficient, then cyclic hopping provides full fading diversity. (As referred to herein, full fading diversity is where every burst within the interleaving depth of a speech frame experiences an independent fading state. This is possible only if the number of frequencies is greater than the number of bursts over which a speech frame is interleaved and the frequencies are sufficiently separated from each other.) However, cyclic hopping does not provide the benefits of interferer diversity and interference averaging. The pseudo-random frequency hopping algorithm

specified in GSM provides interferer diversity and achieves long-term interference averaging but does not guarantee fading diversity (i.e., no frequency repetitions) within the interleaving depth of a speech 10 frame (excerpts from specification, pp. 1-2).

With respect to GSM pseudo-random frequency hopping, if a large amount of spectrum is allocated, then there are many frequencies over which users can hop and repeated frequencies over a short interval are not common. However, in limited spectrum scenarios where the number of frequencies are smaller than the number of bursts over the interleaving depth (40 ms in the speech case), frequency repetitions always occur. This is illustrated in FIG. 1 (Appendix B) on a full rate traffic channel. For full-rate voice users, eight bursts are transmitted over pseudo-randomly generated frequencies (it is assumed for this example that there are eight frequencies to select from: f_0 to f_7). As can be observed from FIG. 1, coded speech frame 1 encounters frequency, f_4, on 3 out of the 8 bursts that it is interleaved across. This implies that speech frame 1 experiences only 6 out of 8 possible independent fading states (assuming there is sufficient separation between each of the frequencies). Similarly, it can be observed for speech frame 2 that frequencies, f_2, f_4 and f_5 are repeated two times each on the 8 bursts over which coded speech frame 2 is interleaved. In this case, speech frame 2 experiences only 5 out of 8 possible independent fading states. In other words, the GSM pseudo-random frequency hopping algorithm does not maximize the number of unique

frequencies (or independent fading states) in this case. This has consequences for low mobility users where the fading tends to be strongly correlated for time duration in excess of the interleaving depth of a speech frame. [n this case, users may hop to the same frequency multiple times, experiencing similar channel fading conditions each time. With typical channel coding schemes employed for speech traffic channels and control signaling channels, increased correlation within the interleaving depth can lead to degradation in error performance (excerpts from specification, pp. 2-3).

Familiarity with GSM is assumed and is not described herein. For example, other than the inventive concept, a form of frequency hopping used in GSM is described in 3GPP TS 45.002, "3rd Generation Partnership Project; Technical Specification Group GERAN; Digital Cellular telecommunications System (Phase 2+); Multiplexing and Multiple Access on the Radio Path (Release 4)." In addition, the inventive concept is implemented using conventional programming techniques, which as such, will not be described herein.

FIG. 2 (Appendix C) shows a high-level block diagram of a representative wireless endpoint 200 for use in accordance with the principles of the invention. Other than the inventive concept, the elements shown in FIG. 2 are well known and will not be described in detail. Wireless endpoint 200 represents a stored-program-control-based processor architecture and includes processor 250, memory 260 (for storing program instructions and data (such

as a set of hopping frequencies), as further described below) and communications interface(s) 265 for coupling to one or more wireless communication paths as represented by path 266 (e.g., 265 represents a wireless transmitter and a wireless receiver). In the context of this invention, e.g., processor 250 and memory 260 implement (among other functions not described herein) a constrained frequency hopping method for selecting frequencies for use in transmission of signals via communications interface 265. A detailed description of the reception and transmission of wireless signals is not necessary for the inventive concept and, as such, is not described herein. Except as noted below, it is assumed that the wireless endpoint 200 is a part of a GSM system (not shown) and is in communication with another wireless endpoint (not shown). Wireless endpoint 200 is representative of any wireless device, e.g., a base station, mobile station, user terminal, etc. (excerpts from specification, pp. 3-4).

In accordance with the invention, hopping frequency sequences are constrained in order to reduce, or minimize, repeated frequencies over a time period T. Consider a class of hopping sequences for which constraints are imposed to minimize repeated frequencies. For example, if the total number of frequencies, N in a hopping set is equal to 4, the hopping sequence is constrained to prevent any repeats within a set of four bursts. Thus across two consecutive sets of four bursts, no frequency would be repeated three or more times.A similar case can be made for $N = 8$. In this case, a constrained

hopping sequence prevents the repetition of any frequency over 8 consecutive bursts (i.e., it guarantees independent fading states). Hence, the maximum frequency repeat across an 8-tuple would be 1. This is shown in FIG. 3 (Appendix D) for an illustrative speech frame 1, which illustrates constrained frequency hopping on a full rate traffic channel. It should be noted that although the negative effects of frequency repetitions decrease for GSM hopping sets with larger values of N, e.g., $N = 12$, the inventive concept still provides improvement.

In accordance with the invention, a hopping state, $\boldsymbol{H}$, is defined to be:

$$\boldsymbol{H} = \{H_0, H_1, ..., H_{F-1}, H_F, ..., H_{N-1}\}, \tag{1}$$

which is a vector of length N, where N is the total number of frequencies available to hop over, and F is $\leq N$ and is the number of frequencies in $\boldsymbol{H}$ over which the wireless endpoint is constrained to hop. $\boldsymbol{H}$ can also be defined as $\boldsymbol{H} = \boldsymbol{A} \cup \boldsymbol{B}$, where

$$\boldsymbol{A} = \{H_0, H_1, ..., H_{F-1}\}, \tag{2}$$

and is the set of F frequencies over which a wireless endpoint is currently allowed to hop and

$$\boldsymbol{B} = \{H_F, ..., H_{N-1}\} \tag{3}$$

and is the set of $(N - F)$ frequencies over which a wireless endpoint is not currently allowed to hop. In other words, $\boldsymbol{H}$ can be viewed as being divided into a set of allowable frequencies ($\boldsymbol{A}$) and a set of prohibited frequencies ($\boldsymbol{B}$). Let the

range of F be defined by F_{min} and F_{max}, where $0 \leq F_{min} < F_{max} \leq N$ (excerpts from

specification, pp. 4-5).

For each hop (hops occur every 4.615 ms frame in the case of GSM), the

transmitter and receiver (of corresponding wireless endpoints as represented by

wireless endpoint 200 of FIG. 2) first use the following procedure in order to

determine a pseudo-random frequency index, S (also referred to herein as a

hopping index sequence value). Steps (4) through (8), below, are found in

section 6.2.3 of the above-mentioned standard, 3GPP TS 45.002. Values for M

(where $0 \leq M \leq 152$) and S (where $0 \leq S \leq N - 1$) are computed as follows:

$$M = T2 + RNTABLE \ ((HSNxor\ TIR) + T3); \tag{4}$$

$$M' = M\ modulo\ (2^\wedge\ NBIN); \tag{5}$$

$$T' = T3\ modulo\ (2^\wedge NBIN); \tag{6}$$

$$if\ M'\ <\ N,\ then \tag{7}$$

$$S=M'; \tag{8}$$

else,

$$S = (M' + T)\ modulo\ N; \tag{9}$$

where the parameters used above are defined in Table One, which is shown in

FIG. 4 (Appendix E) (additional information on the parameters shown in Table

One are found in the above-mentioned standard - 3GPP TS 45.002) (excerpts

from specification, pp. 5-6).

Normally, S is used to select one of the frequencies from **H**. However,

and in accordance with the invention, this pseudo-random frequency index,

S, is now used to select one of the allowable frequencies in **A**. Note, that the pseudo-random frequency index S corresponds to the Mobile Allocation Index (MAI) that is generated by the GSM hopping algorithm for non-zero HSN (Hopping Sequence Number) and MAIO = 0, where MAIO is the Mobile Allocation Index Offset. (In the generation of the pseudo-random frequency index, S, as described below for the inventive concept, MAID=O is employed for all users in a sector to ensure that users within a sector choose identical indices of **H**. This guarantees that the hopping states are identical between all users within a sector. In GSM, each user in a sector is assigned a unique MAIO. This ensures that the frequency hopping sequences between users in the same sector are orthogonal. This concept still applies when using the inventive concept described below (e.g., see equation (11), below) as modulo addition of the MAIO guarantees no intra-sector collisions.) Now, let the sequence of pseudo-random frequency indices generated by the above-described algorithm be **S** = $\{S_0, S_1, S_2, ...\}$. Note that $S_i \in \{0, 1, .., N -1\}$ can be larger than the number of allowable frequencies F. Therefore, in this constrained hopping algorithm, a wireless endpoint hops to:

$$\text{Hopping Frequency} = (Hs + MAIO) \text{ modulo } N \text{ where} \tag{10}$$

$$S' = (S_i) \text{ modulo } F. \tag{11}$$

In other words, and in accordance with the invention, S' is restricted to the allowable set, **A** (excerpts from specification, p. 6).

Turning now to FIG. 5 (Appendix F), an illustrative flow chart is shown for updating the hopping state for a constrained frequency hopping method in accordance with the principles of the invention. In steps 505, 510 and 515, the value of the currently hopped frequency, H_R, is swapped (via the variable c) with H_{F-1}, the last allowable frequency in **A**. Thus, the currently hopped frequency becomes the last element in the set **A**, at position $F-1$. In the step 520, the size of **A** is reduced by decrementing F by one so that the set of frequencies over which the user can hop for the next burst is reduced (thus, excluding the currently hopped frequency, which is now effectively inserted into B). In step 525, if F reaches a pre-determined minimum value, F_{min}, (e.g., 0), F is reset to $F_{,n}''$ and **H** is cyclically shifted to the right by $(F_{,,,,} - Fmi,)$ modulo N, and A is set equal to the first F_{max} elements of **H** (while **B = H-A** (which in some instances my be the null set)). In this way, the oldest candidates in **H** can be considered once again.

Consider an example with the following parameters:

N = 8 frequencies;

F_{min} = 0, F_{max} = 4;

Initial hopping state **H** = {1 3 4 6 2 0 5 7} (obviously, each

number in **H** corresponds to an a priori assigned frequency);

and

Initial value of F = 4.

Table Two, shown in FIG. 6 (Appendix G), illustrates the constrained frequency hopping method when the GSM hopping index sequence, **S**, is illustratively equal to {1 5 2 4 1...} for the first 5 bursts (burst number 0 through burst number 4). As can be observed from Table Two, the first column shows the burst number; the second column shows the associated value of the hopping index sequence for that burst number (taken from S = {1 5 2 4 1 ...}); the third column illustrates the allowable frequency set **A**; the fourth column shows the computed hop frequency in accordance with equations (10) and (11), above; the fifth column shows the updating of **H** (or equivalently **A** (and **B** for that matter)) using the method shown in FIG. 5; and the sixth column illustrates the value of F (excerpts from specification, pp. 6-7).

As noted above, and shown in the first row of Table Two, the initial set of hopping frequencies is **H** = {1 3 4 6 2 0 5 7} and $F = 4$. As such, for the first burst number of 0, **A** is effectively set equal to the first four hopping frequencies of H, as shown in row 2 of Table Two (and the remaining frequencies of **H** are a part of **B**). The hop frequency is computed in accordance with equation (11), above, with the result shown in row 2 of Table Two, i.e., $H_1 = 3$. **H** is now adjusted as shown in the flow chart of FIG. 5, i.e., **H** = { 1 6 4 3 2 0 5 7}. In other words, the frequency value at the computed index position 1 is exchanged with the frequency value at index position $(F - 1)$. In this example, 3 is exchanged with 6 at the 1st and 3rd positions (recalling

that the position index begins at 0). Finally, F is adjusted to 3, as shown in the

final column entry for row 2 of Table Two (excerpts from specification, pp. 7-8).

As a result, since F is now equal to 3, for the next burst number of 1, the

next hop frequency is now restricted to 1, 6, or 4 since the size of **A** has been

reduced as shown in row 3 of Table 2. (Alternatively, the allowed frequency

selections from **H** have been constrained to the first three frequencies.) The

hop frequency is computed in accordance with equation (11), above, with the

result shown in row 3 of Table Two, i.e., $H_2 = 4$. **H** is now adjusted as shown in

the flow chart of FIG. 5, i.e., **H** = {1 6 4 3 2 0 5 7}. In other words, the

frequency value at the computed index position 2 is exchanged with the

frequency value at index position $(F - 1)$. In this example though the positions

are the same since the selected index position and the value of F are the same,

i.e., 3. Therefore, the ordering of the frequencies in **H** does not change.

Finally, F is adjusted to 2, as shown in the final column entry for row 3 of Table

Two.

For the next burst number of 2, the next hop frequency is now restricted

to 1 and 6 since the size of **A** has been reduced as shown in row 4 of Table 2

(since F now equals 2). The hop frequency is computed in accordance with

equation (11), above, with the result shown in row 4 of Table Two, i.e., $H_0 = 1$.

H is now adjusted as shown in the flow chart of FIG. 5, i.e.,

H = {6 1 4 3 2 0 5 7}. In other words, the frequency value at the computed

index position 0 is exchanged with the frequency value at index position $(F - 1)$.

In this example, 1 is exchanged with 6 at the 0th and 1st positions. Finally, F is adjusted to 1, as shown in the final column entry for row 4 of Table Two.

For the next burst number of 3, the next hop frequency is now restricted to 6 since the size of **A** has been reduced as shown in row 5 of Table 2 (since F now equals 1). The hop frequency is computed in accordance with equation (11), above, with the result shown in row 5 of Table Two, i.e., $H_0 = 6$. **H** is now adjusted as shown in the flow chart of FIG. 5, i.e., **H** = {6 1 4 3 2 0 5 7}. In other words, the frequency value at the computed index position 0 is exchanged with the frequency value at index position $(F-1)$. In this example though the positions are the same since the selected index position and the value of F are the same, i.e., 0. As such, the ordering of the frequencies in H does not change. Finally, F is adjusted to 0, as shown in the final column entry for row 5 of Table Two. However, this update to F indicates that the minimum value is reached and hence, **H** is cyclically shifted by $(F_{max} - F_{min})$ mod $N = 4$ and F is reset to $F_{max} = 4$. This is shown by the additional entries in row 5 of columns 5 and 6 of Table Two, where now **H** = {2 0 5 7 6 1 4 3} and $F = 4$. Consequently, for the next burst number of 4, the size of **A** has been increased as shown in row 6 of Table 2 (since F now equals 4) and **A** = {2 0 5 7}. As a result of this constrained frequency hopping method, the hop sequence for the first 5 burst numbers is: 3, 4, 1, 6, (of course assuming that the MAIO associated with this user equals 0, else refer to equation (11)) (excerpts from specification, pp. 8-9).

This algorithm is stated in a general way to allow flexibility in the actual implementation. Although the proposed change ultimately alters the hopping sequence, this algorithm uses the existing GSM hopping framework thus allowing legacy mobiles to be easily supported. In addition, the similarity to the current GSM hopping algorithm allows this feature to be turned off for cases such as large spectrum deployments where little to no gains do not warrant the additional complexity. In such cases, the regular GSM hopping algorithm can be employed.

Note, it is recommended that wireless endpoints run the proposed algorithm at all times, even during silence, in order to maintain the hopping state. Maintaining hopping states is needed to ensure that there are no intra-sector collisions. Since the algorithm considers consecutive bursts spanning multiple frames, the algorithm easily applies to full rate voice (diagonally interleaved) and data (block interleaved) services. The algorithm also applies to half rate voice if $N \geq 8$.

The following should be noted with respect to protocol aspects. When a user enters the system (e.g. at the start of a voice call), the wireless endpoint must know the hopping state, H, the number of currently allowable frequencies, F, and the range of F defined by $Fmin$ and $Fmax$ where $0 \leq Fmin \leq Fmax \leq F$. $Fmin$ and $Fmax$ are assumed to be provided during call setup. The network can provide H and F to a wireless endpoint (e.g., a user terminal) in any number of ways, such as:

1)   These parameters can be provided during call setup signaling from another wireless endpoint along with an associated timestamp by suitable modification of messages used in existing call setup protocols. Since the algorithm to reconstruct the time evolution of **H** and *F* are known, either wireless endpoint can then determine the state information at the current time (effectively providing information on **A**, etc.); or

2)   Alternatively, state information can be autonomously derived at a wireless endpoint by refreshing the state information at pre-determined time instants. For example, the state can be refreshed (i.e., $\mathbf{H} = \{H_0, H_1, ..., H_{N-1}\}$, $F = Fmax$) at pre-determined time instants. The wireless endpoint can then reconstruct the time evolution of **H** and *F* from the previous refresh instant to the current time.

(excerpts from specification, pp. 9-10)

As described above, and in accordance with the invention, a constrained hopping sequence has been described for reducing the rate at which frequencies are repeated (or alternatively, maximizes the number of independent fading states). The use of constrained frequency hopping allows GSM pseudo-random frequency hopping to achieve full fading diversity under spectrum constraints within the interleaving depth of a speech frame. As such, the constrained hopping algorithm maximizes the number of unique

frequencies that occur over the interleaving depth of a speech frame. This permits an improvement in fading diversity performance with negligible impact on interferer diversity and interference averaging capability of the existing GSM pseudo-random hopping algorithm.

The foregoing merely illustrates the principles of the invention and it will thus be appreciated that those skilled in the art will be able to devise numerous alternative arrangements which, although not explicitly described herein, embody the principles of the invention and are within its spirit and scope. For example, although illustrated in the context of pseudo-random frequency selection, other selection methods may be used. Also, although shown as a separate elements, any or all of the elements of FIG. 1 (e.g., 260) may be implemented in a stored-program-controlled processor (excerpts from specification, pp. 10-11).

Appellants respectfully note that the above summary of the invention, including any indication of reference numerals, drawings, figures, paragraphs, page numbers, etc. (collectively referred to as "descriptions" of the application) have been provided solely to comply with the U.S. Patent and Trademark Office's rules concerning the appeal of the claims of the present application. As such, the descriptions above are merely exemplary and should not be construed to limit the claims of the present application in any way whatsoever.

VI.   <u>ISSUES TO BE REVIEWED ON APPEAL</u>

(i.)   Whether or not claims 1, 3, 15-17 and 19 are anticipated by U.S. Patent No. 5,377,221 to Munday et al. ("Munday").

(ii.)   Whether of not claims 1, 5, 6, 27 and 22 are anticipated by U.S. Patent No. 6,345,066 to Haartsen ("Haartsen").

VII.   <u>ARGUMENTS</u>

<u>The claims are patentable over the newly cited references to Munday and Haartsen</u>

Each of the claims of the present invention includes the feature of pseudorandomly selecting a frequency or frequencies from a set of frequencies that has been constrained, reduced or limited "such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of [a] time period, T."

It is respectfully submitted that neither Munday nor Haartsen, taken separately (or in combination), discloses or suggests such a prohibition on frequency selection.

Instead, it appears that after a set of frequencies is selected in Munday or Haartsen any frequency within the set can be re-selected without prohibition. Said another way, neither Munday nor Haartsen is prohibited from re-selecting a frequency, from a set of allowable frequencies, that has

already been selected during a time period, T, as in the claims of the present invention.

Therefore, Applicants respectfully submit that neither Munday nor Haartsen can anticipate (or render obvious) the claims of the present invention.

IX.   CONCLUSION
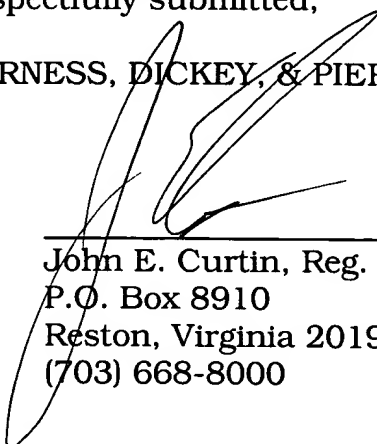
Accordingly, for at least the aforementioned reasons, Appellants respectfully request the Honorable Members of the Board of Patent Appeals and Interferences to reverse each of the outstanding rejections in connection with the present application and allow each of the pending claims 1, 3, 5, 6, 15-17, 19, 21 and 22 in connection with the present application.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No.08-0750 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

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APPENDIX A

1.   (Previously Presented)   A method for use in wireless equipment, the method comprising the steps of:

transmitting signals using frequency hopping over a time period T, by

pseudorandomly selecting a frequency from a set of N frequencies such that over at least a portion of the time period T, the frequency selection is constrained to less than the N frequencies and such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T,

where N is the total number of frequencies available for frequency hopping.

2.   (Cancelled)

3.   (Previously Presented)   A method of frequency hopping for use in wireless equipment, the method comprising the steps of:

storing a set of hopping frequencies; and

pseudorandomly selecting frequencies from the set of hopping frequencies over a time period T by limiting the available frequencies from the hopping set over at least a portion of the time period T such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T.

4.   (Cancelled)

5.   (Previously Presented)   A method of frequency hopping for use in wireless equipment, the method comprising the steps of:

initializing a hopping set to a size of F frequencies, the hopping set used to pseudorandomly select therefrom hopping frequencies over a time period T; and

reducing the size of the hopping set over a portion of the time period T by at least one frequency such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T,

where F is the number of frequencies in a hopping state, H, over which a wireless endpoint is constrained to hop.

6.   (Previously Presented)   A method of frequency hopping for use in wireless equipment, the method comprising the steps of:

initializing a hopping set to a size of N frequencies, the hopping set used to select therefrom hopping frequencies over a time period T; and

pseudorandomly selecting frequencies from the hopping set over the time period T such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T,

where N is the total number of frequencies available for frequency hopping.

7.   (Cancelled)

8.   (Previously Presented)   A method of frequency hopping for use in wireless equipment, where a hopping set is initialized to a size of N frequencies, the hopping set used to select therefrom hopping frequencies over a time period T, the method comprising the steps of:

determining a hopping index value;

modifying the hopping index value by at least the modulo of a number F, where $F \le N$;

pseudorandomly selecting a hopping frequency from the hopping set of a function of the modified hopping index value;

adjusting the order of the hopping set such that the selected hopping frequency is now at a position corresponding to the value of F and such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T;

reducing the value of F; and

returning to the determining step,

where N is the total number of frequencies available for frequency hopping and where F is the number of frequencies in a hopping state, H, over which a wireless endpoint is constrained to hop.

9.   (Previously Presented)   The method of claim 8 wherein when the value of F reaches a predefined minimum value, further including the step of shifting the hopping set in a cyclical direction by a value equal to a difference between a predefined maximum value for F and the minimum value, modulo N.

10.   (Previously Presented)   A method for frequency hopping for use in wireless equipment, the method comprising the steps of:

initializing a hopping set to a size of N frequencies, the hopping set used to select therefrom hopping frequencies over a time period T;

dividing the hopping set into an allowable frequency set and a prohibited frequency set;

pseudorandomly selecting frequencies from the allowable frequency set; and

after at least one frequency selection, adjusting the membership in the allowable frequency set and the prohibited frequency set such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T,

where N is the total number of frequencies available for frequency hopping.

11.   (Cancelled)

12.   (Original)   The method of claim 10 wherein membership in the allowable frequency set and the prohibited frequency set at a current time is derived from knowledge of the allowable frequency set and the prohibited frequency set at an earlier time.

13.   (Previously Presented)   The method of claim 10 wherein knowledge of the allowable frequency set and the prohibited frequency set at a particular time is provided by one wireless endpoint to another wireless endpoint through explicit signaling.

14.   (Original)   The method of claim 10 wherein all N frequencies in the hopping set are assumed allowable at pre-determined time instants.

15.   (Previously Presented)   A pseudorandom frequency hopping method for use in wireless equipment, the method comprising the steps of:

dividing a hopping set into an allowable frequency set and a prohibited frequency set; and

transmitting information associated with the division of the hopping set to another wireless endpoint such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T.

16.   (Original)   The method of claim 15 wherein the transmitted information enables the other wireless endpoint to derive the allowable frequency set.

17.   (Previously Presented)   A wireless endpoint comprising:

a transmitter for transmitting signals using frequency hopping over a time period T; and

a processor for pseudorandomly selecting a frequency from a set of N frequencies such that over at least a portion of the time period T, the frequency selection is constrained to less than the N frequencies and such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T,

where N is the total number of frequencies available for frequency hopping.

18.   (Cancelled)

19.   (Previously Presented)   A wireless endpoint comprising:

a memory for storing a set of hopping frequencies; and

a processor for pseudorandomly selecting frequencies from the set of hopping frequencies over a time period T by limiting the available frequencies from the hopping set over at least a portion of the time period T such that at

least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T.

20.   (Cancelled)

21.   (Previously Presented)   A wireless endpoint comprising:

a memory for storing a hopping set comprising F frequencies, the hopping set used to pseudorandomly select therefrom hopping frequencies over a time period T; and

a processor for reducing the size of the hopping set over a portion of the time period T by at least one frequency such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T,

where F is the number of frequencies in a hopping state, H, over which a wireless endpoint is constrained to hop.

22.   (Previously Presented)   A wireless endpoint comprising:

a memory for storing a hopping set comprising N frequencies, the hopping set used to select therefrom hopping frequencies over a time period T; and

a processor for pseudorandomly selecting frequencies from the hopping set over a time period T such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T,

where N is the total number of frequencies available for frequency hopping.

23.   (Cancelled)

24.   (Previously Presented)   A wireless endpoint comprising:

a memory for storing a hopping set comprising N frequencies, the hopping set used to pseudorandomly select therefrom hopping frequencies over a time period T; and

a processor for (a) determining a hopping index value, (b) modifying the hopping index value by at least the modulo of a number F where $F \le N$, (c) selecting a hopping frequency from the hopping set as a function of the modified hopping index value, (d) adjusting the order of the hopping set such that the selected hopping frequency is now at a position corresponding to the value of F such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T, (e) reducing the value of F; and (f) returning to (a),

where N is the total number of frequencies available for frequency hopping and where F is the number of frequencies in a hopping state, H, over which a wireless endpoint is constrained to hop.

25. (Original)   The wireless endpoint of claim 24 wherein when the value of F reaches a predefined minimum value, the processor further shifts the hopping set in a cyclical direction by a value equal to a difference between a predefined maximum value for F and the minimum value, modulo N.

26. (Previously Presented)   A wireless endpoint comprising:

a memory for storing a hopping set comprising N frequencies, the hopping set used to select therefrom hopping frequencies over a time period T; and

a processor for (a) dividing the hopping set into an allowable frequency set and a prohibited frequency set, (b) pseudorandomly selecting frequencies from the allowable frequency set, and (c) after at least one frequency selection, adjusting the membership in the allowable frequency set and the prohibited frequency set such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T,

where N is the total number of frequencies available for frequency hopping.

27. (Cancelled)

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FIG. 1

Prior Art

Even bits	1	1	1	1	2	2	2	2	3	3	3	3
Odd bits	x	x	x	x	1	1	1	1	2	2	2	2
Frequency	f_3	f_1	f_4	f_0	f_4	f_4	f_5	f_6	f_2	f_2	f_3	f_5

Speech frame 1

Speech frame 2

Bursts

FIG. 2   Balachandran-Kang-Sanwal-Seymour 21-1-3-12
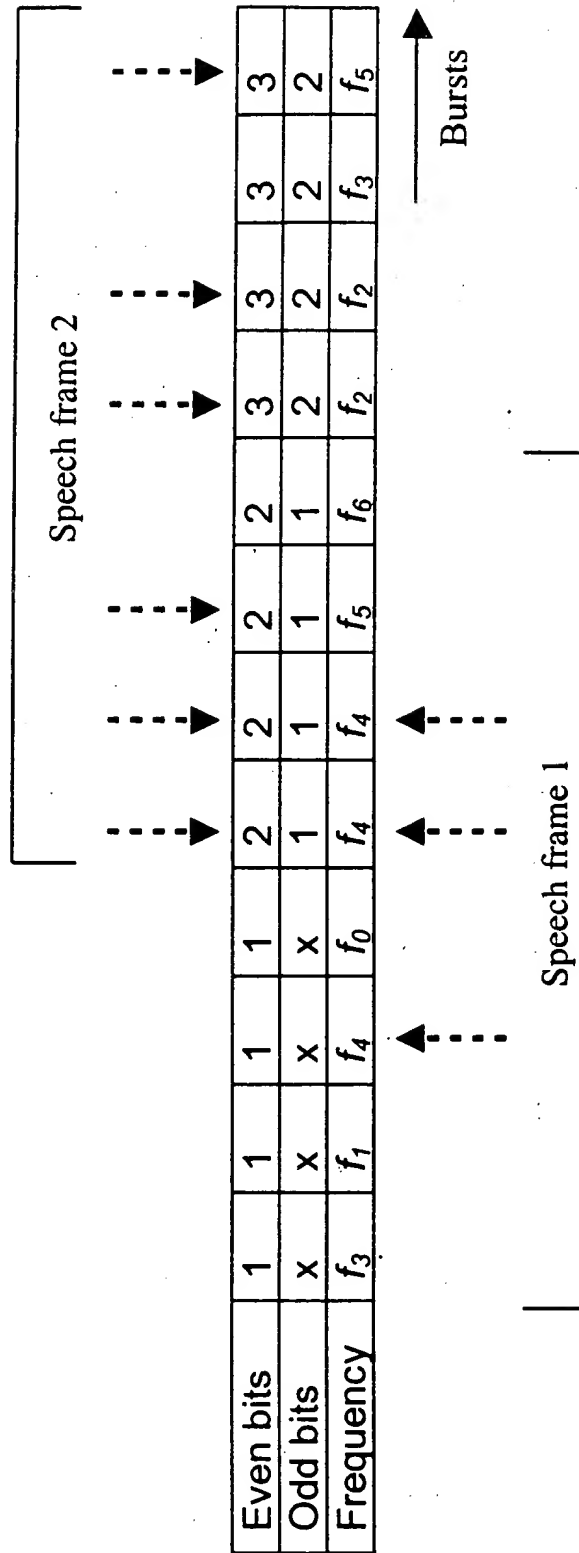
Balachandran-Kang-Sanwal-Seymour 21-1-3-12
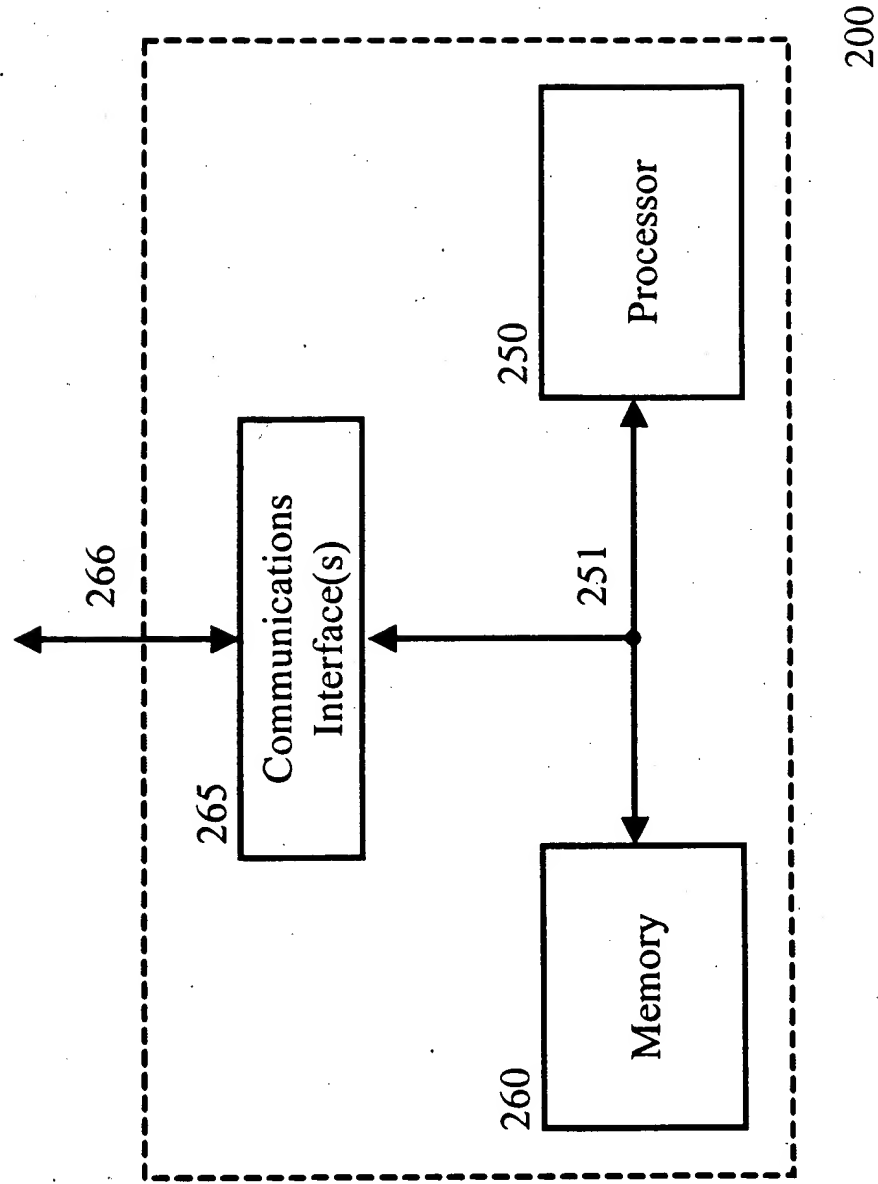
FIG. 3

Even bits	1	1	1	1	2	2	2	2	3	3	3	3
Odd bits	x	x	x	x	1	1	1	1	2	2	2	2
Frequency	f_3	f_1	f_4	f_0	f_7	f_8	f_5	f_6	f_1	f_3	f_0	f_4

Speech frame 1

Bursts

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FIG. 4

Prior Art

Parameter	Definition	Range
TDMA Frame Number, *FN*	TDMA frame number	0 to (26 x 51 x 2048) - 1
Time parameter, *T1R*	[FN div (26 x 51)] modulo 64	0 to 63
Time parameter, *T2*	FN modulo 26	0 to 25
Time parameter, *T3*	FN modulo 51	0 to 50
Hopping Sequence Number (*HSN*)	Used along with other time parameters to generate a pseudo-random hopping sequence	0 to 63
NBIN	Number of bits required to represent *N*	
xor	Bit-wise exclusive or of 8 bit binary operands	

Table One

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FIG. 5

Start

505 — Set $c = H_R$, where $R = S_i$ modulo F

510 — Set $H_R = H_{F-1}$

515 — Set $H_{F-1} = c$

520 — $F = F - 1$

525 — If $F \leq F_{min}$ then Set $F = F_{max}$ and shift $\mathbf{H}$ cyclically to the right $(F_{max}-F_{min})$ modulo N)

End

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FIG. 6

Burst Number	Hopping index	A	Compute Hop Frequency	H	F
--	--	--	--	$H = \{1\,3\,4\,6\,2\,0\,5\,7\}$	$F = 4$
0	1	$A = \{1\,3\,4\,6\}$	$H_{(1 \bmod 4)} = H_1 = 3$	$H = \{1\,6\,4\,3\,2\,0\,5\,7\}$	$F = 3$
1	5	$A = \{1\,6\,4\}$	$H_{(5 \bmod 3)} = H_2 = 4$	$H = \{1\,6\,4\,3\,2\,0\,5\,7\}$	$F = 2$
2	2	$A = \{1\,6\}$	$H_{(2 \bmod 2)} = H_0 = 1$	$H = \{6\,1\,4\,3\,2\,0\,5\,7\}$	$F = 1$
3	4	$A = \{6\}$	$H_{(4 \bmod 1)} = H_0 = 6$	$H = \{6\,1\,4\,3\,2\,0\,5\,7\}$ $H = \{2\,0\,5\,7\,6\,1\,4\,3\}$	$F = 0,$ $F = 4$
4	1	$A = \{2\,0\,5\,7\}$	$H_{(1 \bmod 4)} = H_1 = 0$	$H = \{2\,7\,5\,0\,6\,1\,4\,3\}$	$F = 3$

Table Two